# MULTIHYDRIC COMPOUND DEHYDRATION SYSTEMS, CATALYST COMPOSITIONS, AND METHODS

## CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. patent application Ser. No. 12/973,518 which was filed Dec. 20, 2010, entitled "Multihydric Compound Dehydration Systems, Catalyst Compositions, and Methods", which claims priority to U.S. Provisional Patent Application Ser. No. 61/288,158 which was filed on Dec. 18, 2009, the entirety of each of which is incorporated by reference herein.

## TECHNICAL FIELD

The present disclosure relates to chemical production facilities and methods for producing chemicals. More particularly, the present disclosure provides systems and methods for the dehydration of multihydric compounds such as glycerol.

## BACKGROUND

Chemical production processes and/or systems can have various attributes that may be desirable or undesirable. For example, a process or system may demonstrate relatively good conversion, in that a substantial amount of the reactant is converted. A process or system may demonstrate relatively good selectivity, in that a substantial amount of the product is the desired product. Further the process or system may prove to be robust, in that relatively good conversions and/or selectivities can be achieved over relatively long periods of time without consuming or damaging process or system infrastructure such as reactors, conduit, or catalysts.

With reference to glycerol dehydration as an example, it is desirable to utilize a process or system for dehydrating glycerol to acrolein that would provide a substantial conversion of glycerol to acrolein without frequently shutting down the process or system for the purpose of replacing and/or refurbishing the process or system infrastructure. Utilizing multihydric reactants such as glycerol in production processes can make obtaining a continuous process difficult for at least the reason that the reactant and product can include multiple reactive sites.

Having to replace or refurbish infrastructure utilized in chemical processing can be costly from a safety perspective as well as a financial perspective. From a safety perspective, it is undesirable that chemical facility operators be required to replace or refurbish reactors, conduits, and/or catalysts for at least the reason that the replacement or refurbishment of these facilities can expose the operator to toxic chemicals and/or hazardous situations.

Further, stopping a system during operation is far from the most cost effective process for economically producing a desired product. It is desirable that facility systems and/or processes operate continuously and/or at a steady state. Under most economic models, continuous supply of reagent to a system without shutting the system down provides the most profitable method for production.

The present disclosure provides facilities, systems, methods, and catalyst compositions that can be utilized in the production of chemical compositions such as acrolein.

## SUMMARY

Production facilities for conducting chemically synthetic dehydration processes are provided. According to example implementations, the facilities can include a reaction zone coupled to both a reactant reservoir and a product reservoir, with the reaction zone containing a phosphorous-comprising catalyst, and the facility configured to cyclically produce dehydration product and regenerate the reaction zone, the production of the dehydration product comprising exposing reactant from the reactant reservoir to the catalyst within the reaction zone to form the dehydration product at a production rate, and the regenerating the reaction zone comprising returning the reaction zone to produce the dehydration product at a rate of at least 70% of the production rate.

Chemically synthetic dehydration processes are provided that can include: exposing a multihydric reactant to a dehydration catalyst within a reactor to form a dehydration product; ceasing the providing of the reactant to the reactor; after ceasing the providing of the reactant, providing a gas to the reactor while maintaining the temperature of the catalyst below 800° C.; and after providing the gas, again providing reactant to the reactor.

Chemically synthetic dehydration processes can also include: exposing an aqueous reactant mixture to a dehydration catalyst within a reactor to form a dehydration product, the reactant mixture comprising water and a multihydric reactant; ceasing the providing of the multihydric reactant to the reactor; after ceasing the providing of the multihydric reactant, providing gaseous water to the reactor; and again exposing the reactant mixture to the reactor.

Chemically synthetic dehydration processes can also include: providing glycerol to a reactor having a dehydration catalyst therein, the catalyst transforming at least a portion of glycerol to a dehydration product; ceasing the providing of the glycerol to the reactor; after ceasing the providing of the glycerol, providing an oxidizing reagent to the reactor while maintaining the temperature of the catalyst below 800° C.; and after providing the reagent, again providing glycerol to the reactor.

Chemically synthetic dehydration processes can also include: providing a dehydration catalyst within a reactor; providing glycerol to the reactor via a first conduit; providing water to the reactor via a second conduit; exposing the catalyst to the glycerol to form a dehydration product; ceasing the exposing of the catalyst to the glycerol; after the ceasing of the exposing of the catalyst to the glycerol, exposing the catalyst to the water, wherein the water is in primarily the gaseous form; and after exposing the gaseous water to the catalyst, providing glycerol to the reactor to form a dehydration product.

Chemically synthetic dehydration processes can include: providing a reactor having a dehydration catalyst bed therein; exposing glycerol to the catalyst bed to form a dehydration product from the glycerol; forming carbon by-products within the reactor; ceasing the providing of the glycerol to the catalyst bed; after the ceasing, exposing the reactor to a gas, and heating the contents of the reactor to a temperature sufficient to release at least a portion of the carbon by-products from the reactor; and after the heating of the contents of the reactor, again providing glycerol to within the reactor. Glycerol dehydration catalysts are provided that can include a fumed support material; phosphate; and at least one or more metals from groups 2-12 of the periodic table and/or Rb, K, and Cs.

Glycerol dehydration methods are provided that can include exposing glycerol to a catalyst, with the catalyst comprising a fumed support material, phosphate, and at least one or more metals from groups 2-12 of the periodic table and/or Rb, K, and Cs, the exposing forming one or both of acrolein and acetol.